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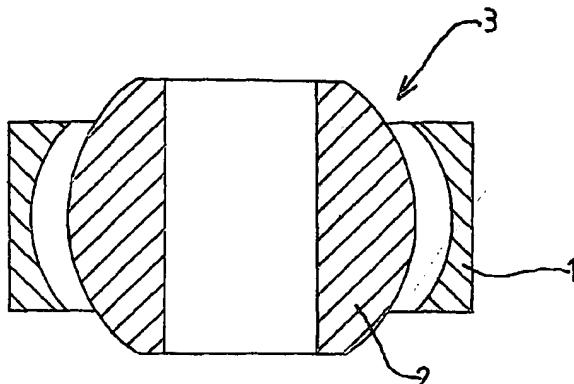
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Published:  
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD OF SWAGING A SPHERICAL BEARING



(57) Abstract: A method of swaging a spherical bearing (3) comprising a ball (2) and a bearing housing (1), the method comprising the steps of: providing a ball (2) and a bearing housing (1) to be swaged around the ball (2); creating a temperature differential between the temperature of the housing (1) and the temperature of the ball (2), the ball (2) being at a lower temperature than the housing (1) such that the relative size of the ball (2) with respect to the housing (1) decreases; inserting the ball (2) in the housing (1); swaging the housing (1) around the ball (2), the ball (2) being cooler than the housing (1) during the swaging process; allowing the ball (2) and housing (1) to return to ambient temperature such that the relative size of the ball (2) with respect to the housing (1) increases.

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## A METHOD OF SWAGING A SPHERICAL BEARING

This invention relates to a method of swaging and more particularly to a  
5 method of swaging a spherical bearing comprising a ball and a housing, the  
bearing housing to be swaged on to the ball.

The process of swaging a bearing housing around a ball to complete the  
assembly of a spherical bearing is a well-known process and various swaging  
10 techniques can be used such as taper die swaging or half-cup swaging.

The so-called spring-back effect occurs when swaging pressure is  
released from the swaged material which returns some way back to its pre-  
swaging condition, potentially creating a gap between the ball and the housing  
15 or, at least, not a close fit between the ball and the housing - see Figure 2 of the  
accompanying drawings.

Particularly when swaging dissimilar materials, for example, a copper  
ball and a steel housing, care must be taken in swaging the harder material, the  
20 steel housing, onto the softer copper ball so as not to deform the softer material  
by creating an irregularly shaped ball or a bad fit between ball and housing.  
Further, when swaging similar materials, it is common to over-swage the  
housing on to the ball so that any spring-back in the swaged material is  
compensated. If spring-back is not compensated, then the swaged part of the  
25 housing will not conform to the shape of the ball meaning a gap is created  
between the edge of the swaged housing and the ball resulting in a loose fitting  
bearing. Consequently, whilst over-swaging can be used to remove or  
minimise spring-back effects so that the inner surface of the swaged housing  
conforms to the shape of the ball when swaging similar materials, over-swaging

cannot be used as a spring-back compensation method when swaging dissimilar materials.

The present invention seeks to provide a swaging technique to swage a  
5 housing onto a ball to produce a spherical bearing, which technique ameliorates  
the problems with conventional swaging processes.

Accordingly, one aspect of the present invention provides a method of  
swaging a spherical bearing comprising a ball and a bearing housing, the  
10 method comprising the steps of:

providing a ball and a bearing housing to be swaged around the ball;  
creating a temperature differential between the temperature of the  
housing and the temperature of the ball, the ball being at a lower temperature  
than the housing such that the relative size of the ball with respect to the  
15 housing decreases;  
inserting the ball in the housing;  
swaging the housing around the ball, the ball being cooler than the  
housing during the swaging process;  
allowing the ball and housing to return to ambient temperature such that  
20 the relative size of the ball with respect to the housing increases.

In order that the present invention may be more readily understood,  
embodiments thereof will now be described, by way of example, with reference  
to the accompanying drawings, in which:

25

Figure 1 is a schematic cross section of a spherical bearing comprising a  
ball and a bearing housing before the bearing housing is swaged on to the ball;

Figure 2 is a schematic cross-sectional detail of the fit between a ball and a bearing housing after the bearing housing has been swaged on to the ball using a conventional swaging technique;

5       Figure 3 is a schematic cross-sectional detail of the fit between a ball and a bearing housing after the housing has been swaged on to the ball in accordance with a method embodying the present invention; and

10      Figure 4 is a schematic cross-section of a spherical bearing being swaged in a taper die swaging process.

Referring to Figure 1, in a swaging process such as a taper die swaging process (as shown in Figure 4), a bearing housing 1 is to be swaged on to a ball 2 to create a spherical bearing 3. Figure 1 shows the ball 2 and housing 1 before swaging. In accordance with embodiments of the present invention, prior to swaging, a temperature differential is established between the temperature of the housing 1 and the temperature of the ball 2. Preferably, this is established by cooling the ball 2 in liquid nitrogen until the ball has reached the temperature of the liquid nitrogen (-196°C). Of course, any other convenient cold medium can be used to cool the ball 2.

In the cooling process, thermal contraction takes place and the ball 2 reduces in size relative to the size of the housing since the housing 1 is maintained at ambient temperature.

25

Once the ball 2 has been cooled to a desired temperature and thermal contraction has taken place, the cooled ball 2 is seated in the housing 1 and the housing 1 is swaged on to the cooled ball. Over-swaging is avoided to minimise stress on the ball 2 and prevent deformation of the ball 2. After

completion of the swaging process, the spherical bearing 3 is removed from the swaging apparatus, be it a taper die or the like, and the spherical bearing 3 is allowed to return to ambient temperature - i.e. both parts of the spherical bearing 3, the housing 1 and the ball 2, return to ambient temperature. In 5 returning to ambient temperature, the ball 2 will undergo thermal expansion effectively growing with respect to the size of the housing and taking up any spring-back effects latent in the swaged housing 1 to produce a spherical bearing 3 with a close-fit between ball and housing.

10        The temperature differential between the housing 1 and the ball 2 can be achieved also by heating the housing 1 as opposed to cooling the ball 2 or, alternatively, thermal expansion of the housing 1 can be caused by heating the housing 1 in combination with cooling the ball 2 which will undergo thermal contraction. Swaging can then take place on the heated housing 1 on to the 15 cooled ball 2, although thermal stresses should be monitored.

In practice, liquid nitrogen offers a convenient cold medium to cool the ball. Cooling the ball in liquid nitrogen until the ball stops effervescing in the liquid nitrogen allows the ball to drop in temperature to in the region of -196°C 20 whereupon significant contraction of the ball 2 has taken place.

In the above example, the ball is manufactured from a copper-based material and the housing is manufactured from steel. It is possible to use the above-described swaging technique when the material of the ball and the 25 housing are the same or similar, but it should be noted that the above technique is particularly advantageous for swaging a housing on to a ball where the housing and ball are made from dissimilar materials.

It should be noted that if one of the two parts of the spherical bearing is softer than the other, then there will be deformation of the softer material which is disadvantageous in itself, but also contributes to increased spring-back. Previously, unacceptable results have been achieved when swaging dissimilar  
5 materials using a taper die swage such as that shown schematically in Figure 4, because of the large bulk of material of the housing to be swaged. Swaging dissimilar materials is not such a problem with a half-cup swage since only a thin lip of the housing material needs to be swaged in that instance. However, the processes embodying the present invention are still advantageous using a  
10 half-cup swage over conventional processes since a close-fit spherical bearing with improved tolerances is made possible.

A further improvement in the fit between ball 2 and housing 1 can be achieved when performing a half-cup swage by preforming the inner surface of  
15 the housing to be swaged. The inner surface of the housing to be swaged on to the ball 2 is normally straight but, in this improvement, the inner surface of the housing is machined to be slightly concave. When swaged onto the ball, the slight concavity improves the close fit and further reduces any spring-back effect.  
20

In the present specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following  
25 claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:

1. A method of swaging a spherical bearing comprising a ball and a bearing housing, the method comprising the steps of:

5 providing a ball and a bearing housing to be swaged around the ball;  
creating a temperature differential between the temperature of the housing and the temperature of the ball, the ball being at a lower temperature than the housing such that the relative size of the ball with respect to the  
10 housing decreases;  
inserting the ball in the housing;  
swaging the housing around the ball, the ball being cooler than the housing during the swaging process;  
allowing the ball and housing to return to ambient temperature such that  
15 the relative size of the ball with respect to the housing increases.

2. A method according to Claim 1, wherein the ball is manufactured of a first material and the housing is manufactured of a second material, the two materials being different from one another.

20

3. A method according to Claim 1 or 2, wherein the temperature differential is created by cooling the ball.

4. A method according to Claim 3, wherein the ball is cooled to below 0°C.

25

5. A method according to Claim 4, wherein the ball is cooled by liquid nitrogen.

6. A method according to any preceding claim, wherein the temperature differential is caused by heating the housing.
7. A method according to any preceding claim, wherein the temperature differential is caused by heating the housing and cooling the ball.
8. A method according to any preceding claim, wherein the swaging step is a taper die swaging process.
- 10 9. A method substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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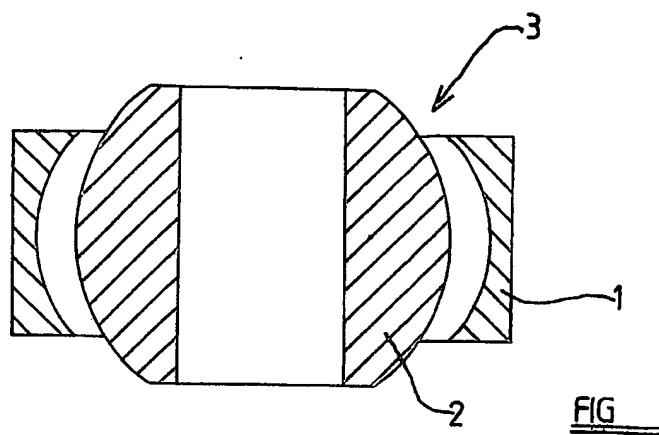


FIG 1

FIG 2

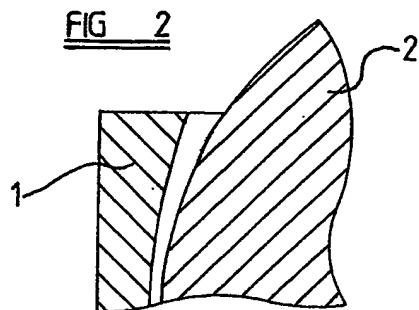


FIG 3

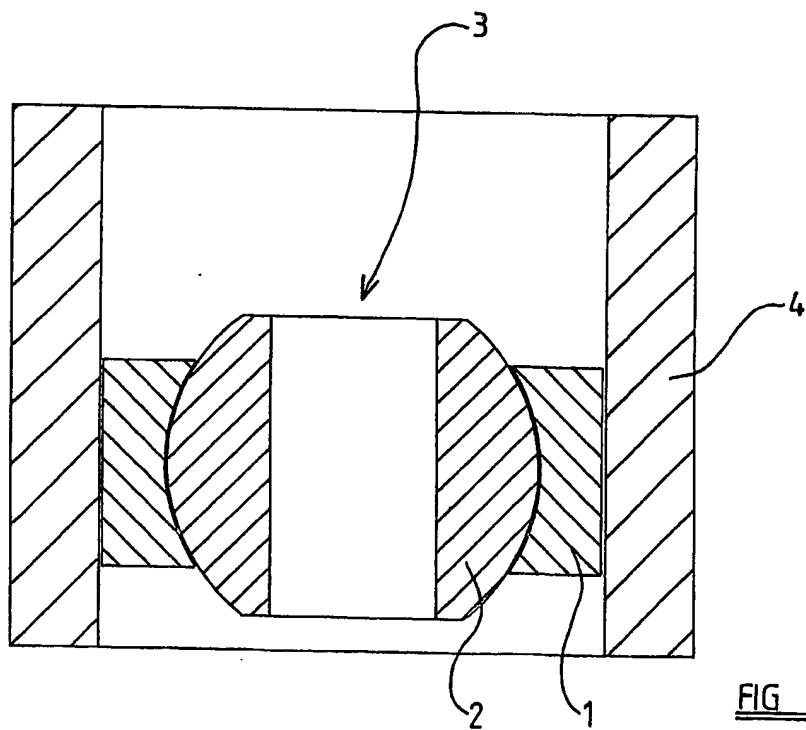
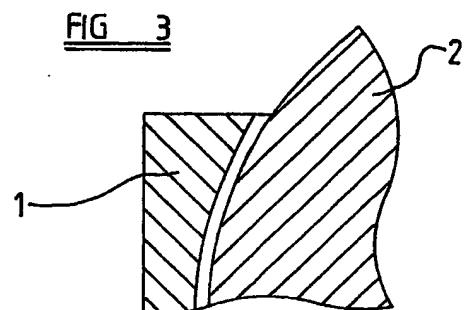


FIG 4

**INTERNATIONAL SEARCH REPORT**

International Application No <b>PCT/GB2004/001303</b>
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<b>A. CLASSIFICATION OF SUBJECT MATTER</b>				
IPC 7 B23P11/00 B23P11/02 F16C23/04 F16C11/06 B21K25/00				
According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b>				
Minimum documentation searched (classification system followed by classification symbols)				
IPC 7 B23P F16C B21K				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the International search (name of data base and, where practical, search terms used)				
EPO-Internal, WPI Data, PAJ				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category *	Citation of document, with indication, where appropriate, of the relevant passages			Relevant to claim No.
A	US 2 995 813 A (BOARD JR DAVID A) 15 August 1961 (1961-08-15) column 5, line 19 – line 34; figures ---			1,8
A	US 4 242 784 A (MCCLOSKEY ALBERT R) 6 January 1981 (1981-01-06) column 4, line 32 – line 66; figures ---			1
A	DATABASE WPI Section PQ, Week 198652 Derwent Publications Ltd., London, GB; Class P56, AN 1986-344963 XP002281190 -& SU 1 227 839 A (ANISIMOV V N), 30 April 1986 (1986-04-30) abstract; figures ---			1-8
				-/-
<input checked="" type="checkbox"/>	Further documents are listed in the continuation of box C.			<input checked="" type="checkbox"/> Patent family members are listed in annex.
<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the International filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the International filing date but later than the priority date claimed</p> <p>"T" later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>				
Date of the actual completion of the International search		Date of mailing of the International search report		
24 May 2004		03/06/2004		
Name and mailing address of the ISA		Authorized officer		
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl Fax: (+31-70) 340-3016		Plastiras, D		

**INTERNATIONAL SEARCH REPORT**International Application No  
**PCT/GB2004/001303****C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 947 063 A (TEEPEL JR GIFFORD H) 2 August 1960 (1960-08-02) column 1, line 15 -column 2, line 6 column 3, line 4 - line 37; figures -----	1
A	US 3 068 552 A (WILLIAMS ARTHUR H ET AL) 18 December 1962 (1962-12-18) column 3, line 8 - line 16; figures -----	1

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB2004/001303

### Box II Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: 9 because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
  
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box III Observations where unity of Invention is lacking (Continuation of Item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

Continuation of Box II.2

Claims Nos.: 9

**Rule 6.2(a) PCT – Reference to drawings in the claim**

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No  
**PCT/GB2004/001303**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2995813	A 15-08-1961	NONE	
US 4242784	A 06-01-1981	NONE	
SU 1227839	A 30-04-1986	SU 1227839 A1	30-04-1986
US 2947063	A 02-08-1960	NONE	
US 3068552	A 18-12-1962	NONE	